



Readability Assessment of Self-Report Hyperacusis Questionnaires

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Abstract

Objective: To assess the overall readability of five currently available hyperacusis questionnaires and to assess the variability in readability of single items within each questionnaire. Design: Comparative study of five self-report hyperacusis questionnaires: (1) Geräuschüberempfindlichkeits-Fragebogen (GUF), (2) Noise Avoidance Questionnaire (NAQ), (3) Hyperacusis Questionnaire (HQ), (4) Sound Sensitive-Tinnitus Index (SSTI), and (5) Inventory of Hyperacusis Symptoms (IHS). Using well established readability formulas Flesh-Kincaid Grade Level (FKGL), Flesch Reading Ease (FRE), Simple Measure of Gobbledygook (SMOG) and FORCAST, in a computerised readability calculation software. Results: Reading levels calculated by each formula varied for every questionnaire. Readability scores ranged from 7.7th to 12.7th grade for overall readability depending on the questionnaire. This was higher than grade reading levels of 5-6th grade (10-12 years old) as recommended by the American Medical Association or 7-8th grade (12-14 years old) as recommended by the US National Institutes of Health. Single item readability analysis based on FKGL revealed that 32% to 70% of single items were written above the recommended grade levels. Conclusion: All five questionnaires are written at close to or exceeding the recommended grade levels. This requires attention from developers but also when interpreting the questionnaire scores obtained in clinic.

Introduction

Hyperacusis is an emergent diagnosis and a growing field of interest in the both the clinical and research communities. It is characterised as the ‘perception of everyday environmental sounds as being overwhelmingly loud or intense’ (Fackrell et al. 2017). Commonly co-incident with tinnitus, hyperacusis has often been assessed and measured using tinnitus-specific questionnaires. Understanding and knowledge of the condition has improved and now there are hyperacusis specific tools for diagnostic and measurement purposes. However, they are limited in number and varying degrees of robustness and psychometric validation (Fackrell and Hoare 2018). In brief, the questionnaires are concerned

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4 gathering examples of when and how hyperacusis affects the individual and to what extent,
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6 by grading the severity of hyperacusis based on the patient's answers.
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9 Questionnaires are a fundamental part of clinical practice, especially when concerned
10 with subjective, self-reported symptoms and conditions, such as hyperacusis. They allow for
11 a time-efficient and structured assessment of symptoms and experience as well as facilitating
12 the assessment of changes over time. Patient-reported outcome measures including
13 questionnaires are an important part of patient-centred care, as they facilitate a deeper
14 understanding of the effects of a condition on a patient's life (Douglas and Kelly-Campbell
15 2018). In order to gather complex information about the effects of a particular condition on
16 one's life, it is important that the intended audience can easily read and understand the
17 questionnaire. This introduces the concept of readability.
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22 The readability of a particular text is the objective measure of the reading skills the
23 person should have in order to be able to understand it (Badarudeen and Sabharwal
24 2010). This is quantified as the number of years of education equivalent to a reading grade
25 level in the US grade system but can also be converted for other country specific systems,
26 e.g. the key stage system in the UK. Commonly used formula are the Flesch Reading Ease
27 (FRE) and Flesch-Kincaid Grade Level (FKGL) (Flesch 1948) . The Simple Measure of
28 Gobbledygook (SMOG; (McLaughlin 1969) is recommended for use with healthcare
29 materials as it is based on more recent criteria for determining reading grade level, and has
30 been reported to be the most suited and practical for application to health care materials
31 (Wang et al. 2013). These formulas take into consideration number of syllables per word and
32 or average words per sentence and are typically meant for use with prose-like text. This is
33 problematic as questionnaires are rarely written in prose-like form, and are more typical to
34 have a disjointed or stem and leaf format. The FORCAST formula (Caylor et al. 1973) is
35 deemed to be most suited to assessing readability of text not in prose-like form such as
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questionnaires, forms, lists test and job materials (Atcherson et al. 2013). It does not count number of sentences, or their average length but rather counts the number of monosyllabic words.

Single item analysis is another area of difficulty, as currently there are no widely used and validated readability formulas developed for single-item analysis specifically. Calderon and Morales et al. (2006) applied the FRE and FKGL to single item analysis of Quality of Life Questionnaires after combining stem-leaf format questions to form full sentences, in order to comply with recommendations to only assess running text (Flesch 1979). This method was also used by Betschart, Abt et al. (2018), and appears to be successful in overcoming the methodological challenge of assessing single items not in prose-like form.

Readability is an integral part of health literacy, definitions of which vary in the literature, however a systematic review by Sørensen et al. (2012) arrived at the following definition after thematic analysis of 17 eligible publications:

'Health literacy is linked to literacy and entails people's knowledge, motivation and competences to access, understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course.'

Despite the importance of health literacy it is commonly neglected, a concerning issue given that health literacy is the single best predictor of an individual's health status (Badarudeen and Sabharwal 2010). In the US over \$230 billion a year is linked to low adult literacy, with nearly 50% of Americans finding understanding and using health information difficult (ProLiteracy 2019). In the UK, current health information is written at a level too complex for 43% of adults aged 16-65, if numeracy skills are required for comprehension of the information the figure rises to 61% (Rowlands et al. 2015). Ensuring that patients are able to fully understand matters pertaining to their health is simply a part of good practice,

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4 therefore adult health materials should be prepared at the lowest possible level of reading
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6 difficulty which is generally 5th grade (Weiss and Coyne 1997). More specifically, important
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8 links between health literacy and rehabilitation outcomes for patients in the audiology clinic
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10 have been reported by (Gilligan and Weinstein 2014). The authors argue that in order for
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12 patient-centred care to succeed we need to ensure that the tools we use to enable the patient
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14 perspective within management options, are suitable i.e. readable by their target audience. If
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16 the readability of a questionnaire is too difficult this can lead to patients rejecting the
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18 questionnaire, providing partial information or answering in a way that does not truly reflect
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20 their experience (Atcherson et al. 2013). Therefore, reading grade levels of 5 to 6th grade (10-
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22 12 years old) are recommended by the American Medical Association (AMA) (Weiss 2007)
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24 and 7th to 8th grade (12-14 years old) are recommended by the U.S. National Institutes of
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26 Health (NIH) (Medlineplus 2017). Studies reporting on readability for tinnitus questionnaires
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28 (Atcherson, Zraick, and Brasseur 2011), Auditory Processing Disorder questionnaires
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30 (Atcherson et al. 2013), and Adult Audiology Rehabilitation outcome measures (Douglas and
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32 Kelly-Campbell 2018) indicate that readability of questionnaires and patient-reported
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34 outcome measures largely exceed the recommended reading levels mentioned above. These
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36 studies evaluated the overall readability of questionnaires, meaning that information about
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38 the variability in the readability of single items was not addressed. This is an important
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40 omission as very easy to read items can potentially skew the overall readability of the
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42 questionnaire towards lower grade, hiding the more difficult items; the resulting readability
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44 level would not reflect the true difficulty of the text (Homan, Hewitt, and Linder 1994;
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46 Betschart et al. 2018). Unlike running prose in which context can help the reader comprehend
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48 the meaning of a given text, respondents are required and expected to comprehend each item
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50 in a questionnaire separately (Calderón et al. 2006). Therefore, analysis of single items
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52 allows for a more comprehensive assessment of readability and can highlight particular items
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4 within a questionnaire that require caution when interpreting patient's answers (Betschart et
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6 al. 2018).

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8 The purpose of the present study is to assess the overall readability of five currently
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10 available hyperacusis questionnaires and to assess the variability in readability of single items
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12 within each questionnaire.
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15 16 17 **Methods**

18 19 20 *Questionnaire selection*

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22 Questionnaires were selected based on the following criteria: (i) focus on quantifying
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24 and characterising an individual's sound tolerance difficulties, (ii) questionnaire designed to
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26 be completed by the patient without help or guidance from a clinician. Questionnaires that
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28 were designed to be administered as a part of a semi-structured interview, or with clinician
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30 involvement were excluded. Whether the questionnaire was used in clinical practice or
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32 whether it undergone psychometric validation were not considered as exclusion criteria. Five
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34 questionnaires meeting the above criteria were selected for analysis:
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38 • Geräuschüberempfindlichkeits-Fragebogen (GUF); English translation
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40 (Nelting and Finlayson 2004)
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42 • Noise Avoidance Questionnaire (NAQ); English translation (Bläsing et al.
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44 2010)
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46 • Hyperacusis Questionnaire (HQ) (Khalifa et al. 2002)
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48 • Sound Sensitive-Tinnitus Index (SSTI) (Greenberg 2017)
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50 • Inventory of Hyperacusis Symptoms (IHS) (Greenberg and Carlos 2018)
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Formula selection

There are a number of readability formula in existence; however no widely used formula that were specifically designed for single-item analysis. We selected the FRE, FKGL as they are most frequently utilised in readability literature facilitating comparison between the present study and published literature; the FORCAST as it is deemed the most suitable for readability analysis of questionnaires; and the SMOG formula has been reported to be most consistent, and most appropriate for application to healthcare material given it has an expected comprehension of 100% (Wang et al. 2013).

The FKGL, FORCAST and SMOG formulas give reading grade level scores, the higher the grade the more difficult the text it. The FRE is scored on a scale from 0-100 where a lower number is equivalent to a higher grade level score.

Questionnaire format

English versions of the questionnaires were first copied into a Word document, copying the exact format that was found in the source by MMG. MS then checked the copied versions for accuracy against the original source. To assess the overall readability of each questionnaire full sentences were formed from any preamble statements and question options; stem and leaf format questions were combined to form full sentences for each option. Question options that were short repeated words e.g. as with a 4 point scale ‘never, sometimes, often, very often’, are likely to score very easy and skew results, were removed from the analysis. This approach has been utilised by Calderon, Morales et al. (2006) and later by Betschart, Abt et al. (2018), based on recommendation from Flesch, that the FRE should only be used to test running text (Flesch 1979). All additional text including references, notes to the clinician were excluded from the analysis.

Readability analysis

Readability analysis was conducted using the software package Readability Studio Professional Edition version 2015 for Windows, (Oleander Software, Ltd, Vandalia, OH, USA). Descriptive statistics for mean, median, range and standard deviation were calculated using Microsoft Excel 2016 for Windows 10.

The readability analysis was conducted in three parts:

- (1) Readability assessment of the questionnaires in their original format using the FORCAST formula.
- (2) Readability assessment of the questionnaires where each item was manipulated to form full sentences, using the FRE, FKGL and SMOG formulas.
- (3) Readability assessment of single items comprising each questionnaire, using the FRE and FKGL formulas, in keeping with the approach utilised by Calderon, Morales et al. (2006).

Results

Table one below details the factors that affect readability, and serves to illustrate the relative variability of each of the questionnaires. These statistics were extracted from the readability software, and can be used as a starting point for improving the readability of the questionnaires, by highlighting high numbers of complex words and sentence lengths, factors that increase the difficulty of a given text. Although it is important to note that the factors included in the table are not necessarily taken into consideration by the four formulas utilised in the study.

Table 1. Factors affecting readability for each questionnaire

Questionnaire	No. of items	Total words	Complex words (3+syllables)	Long words (6+ characters)	Average sentence length (words)	Number of difficult sentences (more than 22 words)
GUF	15	374	21 (5.6%)	148 (39.6%)	12.5	0
NAQ	25	542	54 (10%)	166 (30.6%)	8.6	0
HQ	18	301	40 (13.3%)	86 (28.6%)	6.4	0
SSTI	20	712	56 (7.9%)	160 (22.5%)	17.7	3
IHS	25	429	31 (7.2%)	115 (26.8%)	10.2	0
Median	20	429	40	148	10.2	0
Mean	19.8	474	40.4	135	11.08	0.6
SD	5.26	157.5	14.94	33.75	4.32	1.34
Range	14-25	313-712	21-56	86-166	6.4-17.7	0-3

Readability analysis using the FORCAST formula

Readability analysis of the questionnaires in the original formats using the FORCAST formula showed that the overall reading grade level for each of the 5 questionnaires exceeded the recommended reading level of 5-6th (10-12 years old) and 7th to 8th grade (12-14 years old), see table 2. The software reports results according to the US grade system, which can be converted to country specific school years, in this case the UK year-group system, can be inferred by adding 1 year to the US grade results.

Table 2. FORCAST, FRE, FKGL and SMOG reading grade levels

Questionnaire	FORCAST	FRE	FKGL	SMOG
GUF	12.1	62	8.30	10
NAQ	12.7	68	8.90	9.6
HQ	9.9	63	7.80	10.8
SSTI	8.9	58	10.1	12.7
IHS	9.9	65	7.70	11.1
<i>median</i>	9.9	63	8.3	10.8
<i>mean</i>	10.7	63.2	8.56	10.84
<i>SD</i>	1.62	3.7	0.98	1.20

Note that where a score has an integer after a decimal point e.g. 12.1 this means that the reading grade level is 12th grade, 1st month of academic year. FORCAST reading grade levels are for questionnaires in their original format. FRE, FKGL and SMOG scores are for the questionnaires in the manipulated full-sentence format. Conversion from FRE to grade level: 90-100- 5th grade; 80-90- 6th grade; 70 to 80- 7th grade; 60-70- 8th and 9th grade; 50-60- 10th-12th grade; 30-50- college; 0 to 30- college graduate

Readability analysis using the FRE, FKGL and SMOG formulas

The grade levels as calculated by the FRE, FKGL and SMOG formulas for the questionnaires in the manipulated, full sentence format are shown in Table 2. There are some evident differences in the reading grade levels for each questionnaire depending on the readability formula used. With reference to the more conservative recommendations, all questionnaires exceed the grade 5-6 reading level. However, four out of the five questionnaires fall within the 7th to 8th grade level according to the FRE, and three out of five fall within the same criteria according to the FKGL. The SSTI has the highest reading grade levels as determined by each of the three formulas thus requiring a more advanced reading age than compared to the other questionnaires. Interestingly, SMOG reading grade levels for the IHS and the HQ exceed both the recommendations; however fall within the recommendations according to the FKGL formula. The differences in reading grade levels

could be attributed to differences between the formulas, although notably the SMOG formula yielded higher-grade reading levels for all questionnaires than compared to FRE and FKGL.

Figure 1 is a useful visualisation of how average words per sentence and average syllables per word map on to reading grade levels calculated by the FRE. The SSTI reading grade level as calculated by the FRE is equivalent to that of a 10-12th grader (15-18 years old), as it has a high average number of words per sentence and average syllables per word. It is important to note that the FRE assumes that plain English has a score between 60-70, approximately equivalent to 7th grade level, however the recommendations for healthcare materials is even lower.

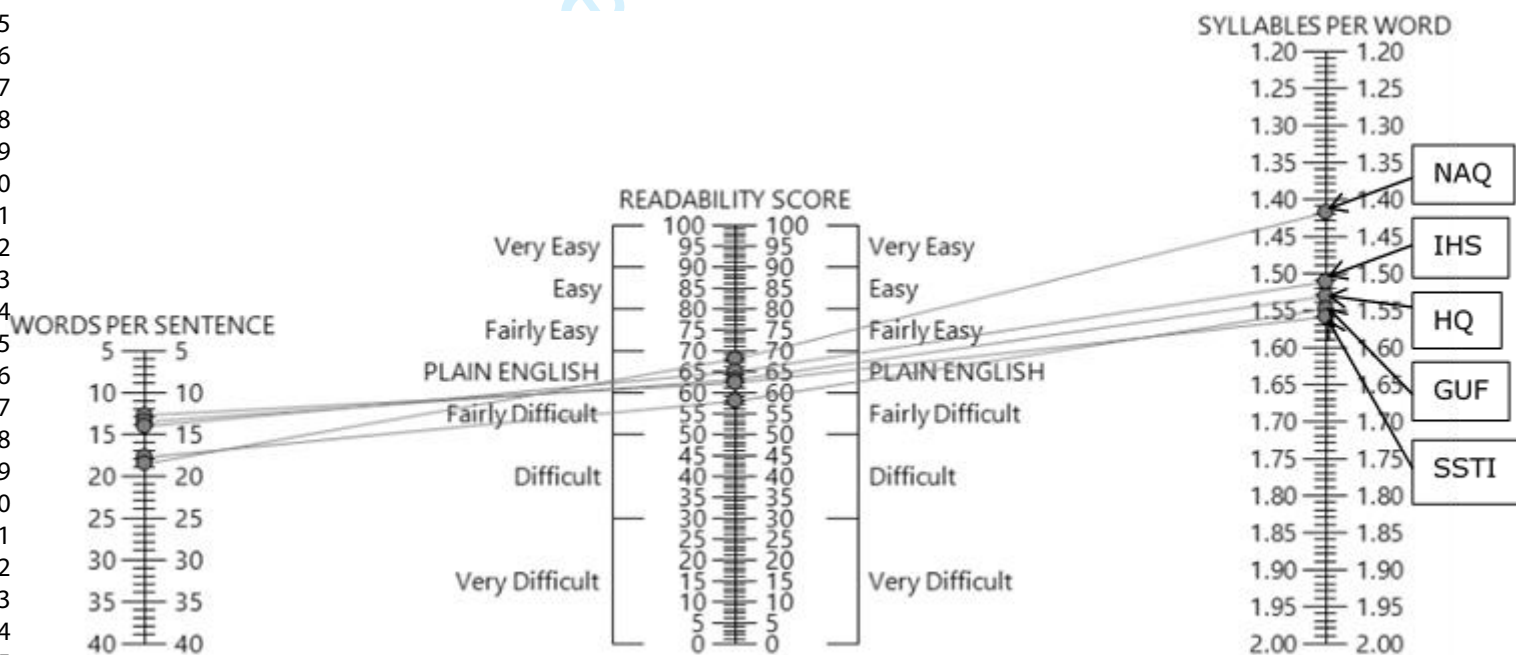


Figure 1. Flesch Readability Chart for the five questionnaires showing the relation between average words per sentence, average syllables per word and the readability score yielded.

Readability analysis of single items using FRE and FGKL formulas

Single item analysis revealed variability in single item readability within each questionnaire (figure 2). Results show that a readability level above the maximum recommended 8th grade level was found for 47% of items in the GUF; 44% of items in the NAQ; 39% of items in the HQ; 70% of items in the SSTI and 32% of items in the IHS. The highest score was a grade level of 16 according to the FKGL, and was found for single items within the NAQ, SSTI, IHS. According to the FRE, scores of 6, 15 and 27 were found for single items within the IHS, SSTI and NAQ respectively, meaning that a person would need the reading ability of a postgraduate to understand them.

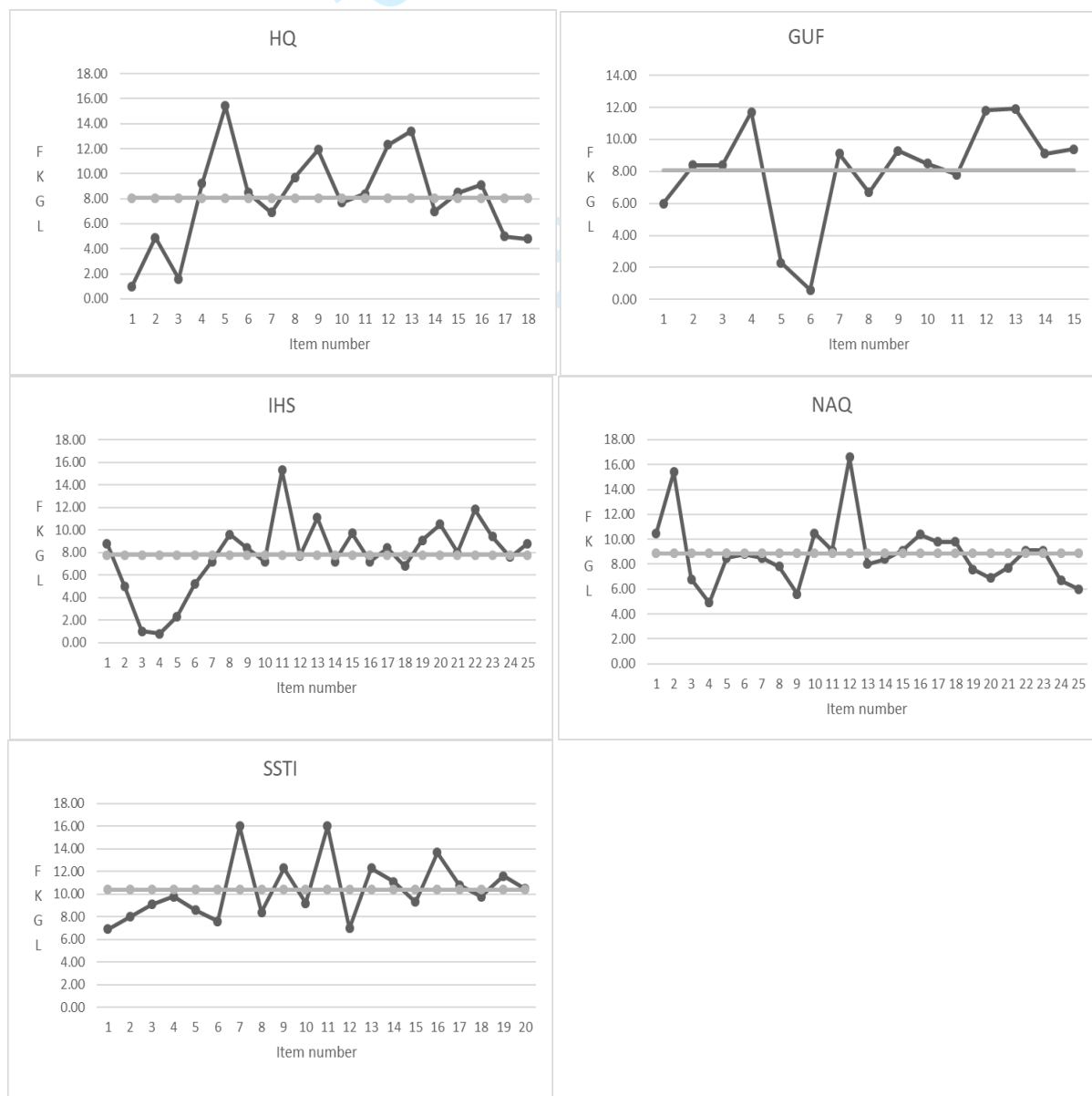


Figure 2. Reading grade levels for single items of questionnaires. Solid light grey line represents the mean readability score for single items for each questionnaire.

Discussion

The present study assessed the readability of the currently available self-report hyperacusis questionnaires. Results revealed a range of reading grade levels for each questionnaire and across formulas, most of which clearly exceeded the recommended reading grade levels of 5-6th grade and 7-8th grade endorsed by the AMA and the NIH, respectively.

Readability analysis using the FORCAST formula

All questionnaires exceeded the grade reading level recommendations when the FORCAST formula was used, this is the only formula that is meant for text that is a non-prose format e.g. questionnaires. Similar to these findings are reports from Atcherson, Zraick and Brasseur (2011) who used FORCAST to assess tinnitus questionnaire readability. However, the expected comprehension for the FORCAST formula is only 35% and so it may not be the most appropriate formula to use for the healthcare setting. Primarily because ensuring that patients can comprehend 100% of the information they receive relating to their healthcare being an integral part of healthcare literacy and facilitating better healthcare outcomes for patients (Gilligan and Weinstein 2014; Douglas and Kelly-Campbell 2018). As patient reported outcome measures are utilised more clinical practice, research and used to inform healthcare services, it is crucial that patients are able to read and understand the questions (El-Daly et al. 2016). The NAQ yielded the highest grade reading level with the FORCAST of 12.7th grade. Assuming the average reading age of 5-6th grade (10-11 years old) this would mean that around 5 million adults in England would not be able to read and comprehend the questionnaires (National Literacy Trust 2017). In the US this would translate to approximately 30 million adults that are classified as having a below basic health literacy

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4 level not being able to comprehend the questionnaires (U.S. Department of Health and
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6 Human Services 2008).
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10 ***Readability analysis using the FRE, FGKL and SMOG formulas***

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12 A common report in the readability literature is around the variability in the grade
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14 levels given by different formulas, which can be attributed to the parameters analysed by
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16 each formula (Atcherson et al. 2013). Similarly, in the present study, grade levels for a
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18 particular questionnaire varied approximately three grades depending on the formula (see
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20 table 2).
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24 SMOG reading grade levels for every questionnaire clearly exceeded even the more
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26 lax recommendation of 7 to 8th grade reading level, and whilst correlation analyses were not
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28 conducted, the SMOG and FKGL generally showed the same trend. Similar results have been
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30 reported for audiological rehabilitation outcome measures by Douglas and Kelly-Campbell
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32 (2018), with the SMOG and FORCAST formulas yielding the highest reading grade level.
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34 The SMOG formula is not only recommended for use with healthcare materials but is based
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36 on more recent criteria for determining readability (Wang et al. 2013).
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40 A difficulty that is not often discussed in the literature concerned with readability of
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42 questionnaires is that fact that other than the FORCAST, the other formulas should be applied
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44 to text in full sentences. Hence, why the manipulation of the questionnaires to achieve the
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46 most appropriate format for the formulas was carried out, yet it does highlight the strong need
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48 for a formula that can meet the specific requirements of 100% comprehension as well as
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50 being able to tackle non-prose like, stem-leaf formats as is common of questionnaires.
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54 ***Readability analysis of single items using the FRE and FGKL formulas***

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56 Readability analysis of single-items allowed further insight into the readability issues
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58 within each questionnaire. The SSTI clearly exceeded the other four questionnaires, with
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4 70% of items yielding a grade level above the maximum 8th grade recommendation. This
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6 could affect the clinical usefulness of information gathered with these questionnaires, as
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8 patients with lower reading ages would be at risk of rejecting the questionnaires, or providing
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10 inaccurate information (Atcherson, Zraick, and Brasseur 2011). Whilst there are no
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12 guidelines on single item readability, reports in the literature suggest that the best way to
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14 facilitate meaningful, reliable and useful information gathering using questionnaires as a tool
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16 would be to ensure that every item is readable by patients (Gilligan and Weinstein 2014).
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20 Readability is part of the wider concept of health literacy; poorer health literacy is
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22 associated with poorer healthcare outcomes. Douglas and Kelly-Campbell (2018) argue that
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24 ignoring basics such as the readability of self-report patient materials, such as questionnaires,
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26 can lead to patient's issues not being fully addressed for example if they have misunderstood
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28 questions or answered inaccurately and even leading to early discharge of the patient from
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30 the service. In research the issue may impact the accuracy of evaluating interventions, if the
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32 participant have not been able to understand a patient-report tool used as the outcome
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34 measure (Douglas and Kelly-Campbell 2018) essentially invalidating the empirical data
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36 collected (Atcherson, Zraick, and Brasseur 2011). Apart from potentially affecting the
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38 validity of the information gathered, the use of patient materials that are not suitable for even
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40 those with the lowest health literacy can create barriers to patients in accessing services they
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42 need (Rajah et al. 2018). There may be additional factors to be aware of, especially for
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44 patients with hyperacusis. It is common to have patients fill in questionnaires as they are
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46 waiting for appointments. Clinic waiting rooms are known to be busy and commonly noisy
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48 environments that can induce stress in patients even without hyperacusis, especially if noise
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50 levels exceed ambient noise level recommendations (Hill and LaVela 2015). A difficult
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52 soundscape coupled with a questionnaire that is written at a reading exceeding that of the
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54 patient, could introduce further difficulties for patients with hyperacusis.
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4 Improving the readability of single items and therefore the overall readability should
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6 be a consideration for developers of questionnaires. Mono- or bi-syllabic word substitutions
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8 for unfamiliar medical words and reduction in length of sentences would help to improve
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10 readability (El-Daly et al. 2016). Edited versions of the questionnaires should undergo
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12 validation.
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15 16 17 ***Limitations***

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19 A limitation of the present study, as with other reports, is that mother factors that
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21 affect readability such as format, text style and size and images (Atcherson, Zraick, and
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23 Brasseur 2011) were not analysed. Additionally, the lack of formulas appropriate for single
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25 item analysis required some manipulation of the questionnaires away from their original
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27 format. Only English versions of the questionnaires were analysed, so the reported results
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29 cannot be generalised to other translations that exist. Readability analysis on the original
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31 German language versions of the GUF and NAQ may be of clinical interest.
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34 Despite the limitations, the present study presents important information on the readability of
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36 hyperacusis questionnaires, utilising format appropriate formulas and providing an insight
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38 into the single-item variability within some of the currently available questionnaires.
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42 43 44 **Conclusion**

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46 Researchers and developers should consider the overall readability of the developed
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48 questionnaires, ensuring that it is in keeping with recommendations. Furthermore, a greater
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50 awareness of and adherence to the recommendations should be made on the single item level,
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52 so that there is less variability within a questionnaire. Researchers and developers should also
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54 be aware of which questions may need some caution when interpreting patient answers, in the
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56 case that it has a very difficult readability. Further work on single item readability formula
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58 and methodological approaches including the creation of a computerised version of the
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4 formula, to allow for more robust single item analysis would be a welcome addition to the
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6 research area.
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10 Acknowledgements

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12 Declaration of interest

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14 No conflicts of interest to disclose.
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